THERMODYNAMICS 1

A PROBLEM SOLVING PRESENTATION

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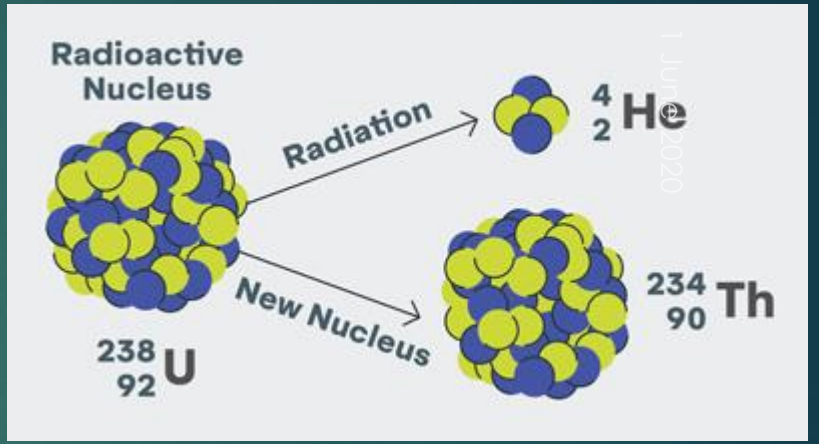
Thermodynamics part-1:

1) Find the work posses for a Helium gas at 20^0C

A. 609 KJ/kg B. 168 KJ/kg C. 229 KJ/kg D. 339 KJ/kg



Solution:

W = m R T = m (8.314 / M) T

For helium, M = 4

W/m = (8.314/4)(20 + 273)

= 609 KJ/kg

Helium is named after the Greek word for the sun, helios, as it was first identified in the sun's corona (the sun is composed of 25% helium). The second most abundant element in the universe, helium is scarce on Earth. A product of nuclear fusion and radioactive decay, it is the lightest noble gas, colorless, odorless, and inert with a low boiling point.

https://www.acs.org/content/acs/en/greenchemistry/research-innovation/endangered-elements/helium.html

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2) Find the enthalpy of Helium if its internal energy is 200 KJ/kg

144 KJ/kg B. 223.42 KJ/kg C. 333.42 KJ/kg D. 168 KJ/kg

Solution:

R = 8.314/4 = 2.0785

K = 1.667 for helium

C_p = k R/(k - 1) = 1.667(2.0785)/(1.667 – 1)

= 5.195 KJ/kg-K

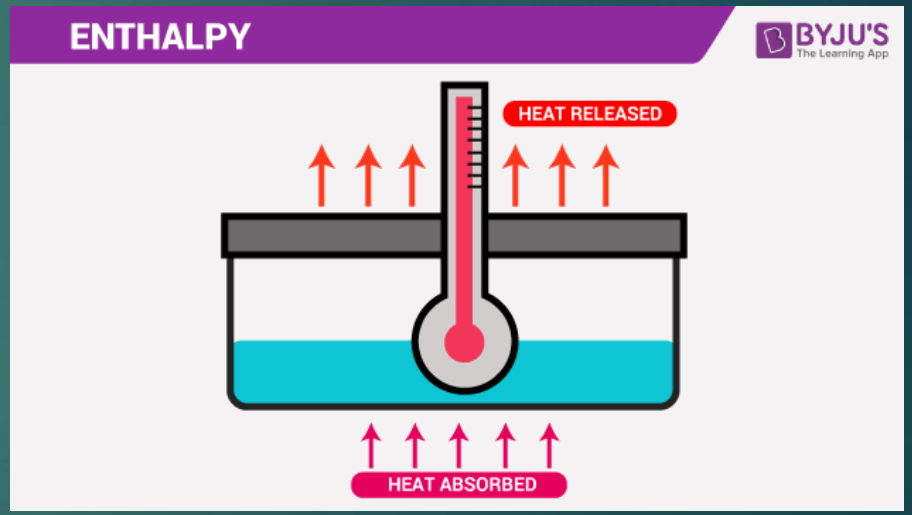
C_v = R/(k – 1) = 2.0785/(1.667 – 1)

= 3.116 KJ/kg – K

$\Delta h/\Delta U = C_p/C_v$

$\Delta h/200 = 5.195/3.116$

Δh = 333.42 KJ/kg



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3) Compute the mass of a 2 m^3 propane at 280 kpa and 40˚C.

A. 6.47 kg B. 5.1 kg C. 10.20 kg D. 9.47 kg

Propane is commonly **used** for space and water heating, for cooking, and as fuel for engine applications such as forklifts, farm irrigation engines, fleet vehicles, and buses; however, its applications are rapidly growing due to new technology developments. When **used** as vehicle fuel, **propane** is known as **propane** autogas.

Solution:

Propane is $C_3 H_3$----------M = 12(3) + 8(1) = 44

PV = m R T

280(2) = m (8.314/44)(40 + 273)

m = 9.47 kg

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4) Compute the air flow in ft^3/min of mechanical ventilation required to exhaust an accumulation of refrigerant due to leaks of the system capable of revolving air from the machinery room for a mass of 4 lbs refrigerant.

A. 200 B. 210 C. 220 D. 230

A **refrigerant** is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle. In most cycles it undergoes phase transitions from a liquid to a gas and back again. Many working fluids have been used for such purposes.

Solution:

$$Q = 100 \times G^{0.5}\ ft^3/min$$

$$Q = 100 \times (4)^{0.5} = 200\ ft^3/min$$

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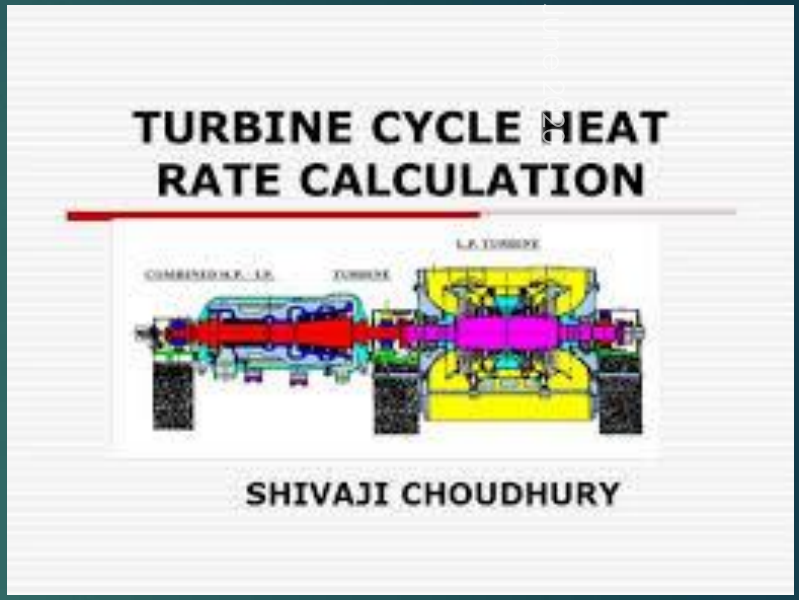
5) A thermal power plant has a heat rate of 11,363 Btu/kw-hr. Find the thermal efficiency of the plant.

A. 28% B. 30% C. 34% D. 40%



Solution:

e_{th} = 3412/Heat rate = 3412/11,363 = 30%

Heat rate is the common measure of system efficiency in a steam power plant. It is defined as "the energy input to a system, typically in Btu/kWh, divided by the electricity generated, in kW." Mathematically

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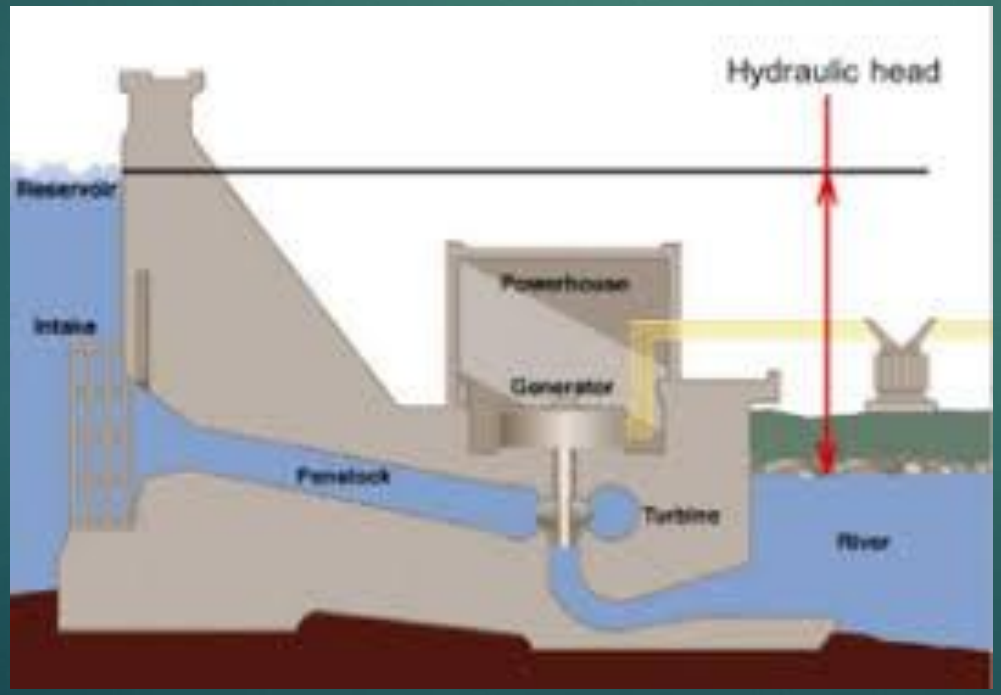
6) Find the loss of head in the pipe entrance if speed of flow is 10 m/s.

5.10 m B. 10.2 m C. 17.4 m D. 2.55 m

Solution:

Loss at entrance = 0.5 ($v^2/2g$) = 0.5 [10^2 / 2(9.81)] = 2.55 m



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7) Find the pressure at the 100 fathom depth of water in kpag.

A. 1,793.96 kpag B. 1,893.96 kpag C. 1,993.96 kpag D. 1,693.96 kpag

Solution:

H = 100 fathom x 6 = 600 ft

P = w h = (600/3.281)(9.81) = 1,793.96 kpag

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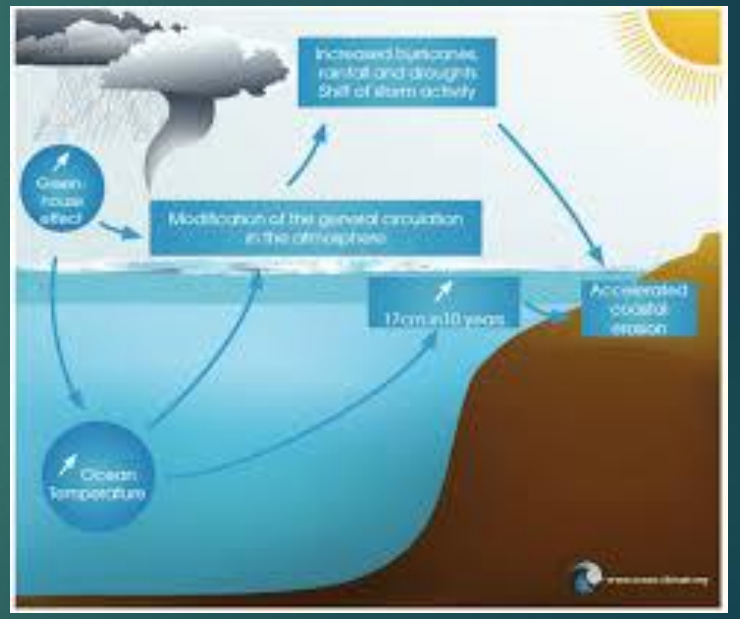
8) Find the depth in furlong of the ocean (SG = 1.03) if the pressure at the sea bed is 2,032.56 kpag.

A. 1 B. 2 C. 3 D. 4


Increased hurricanes, rainfall and droughts
Shift of storm activity
Green house effect
Modification of the general circulation in the atmosphere
17cm in 10 years
Accelerated coastal erosion
Ocean Temperature

Solution:

P = w h

2,032.56 = (1.03 x 9.81) h

h = 201.158 m x 3.281 ft/m x 1 yd/3ft x 1 furlong/220yd = 1 furlong

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9) Find the mass of 10 quartz of water.

A. 10.46 kg B. 9.46 kg C. 11.46 kg D. 8.46 kg

Solution:

$V = 10\ quartz \times 1gal/4quartz \times 3.785li/1gal \times 1m^3/1000li$

$V = 0.0094625 \times 10^{-3}m^3$

$w = m/V$

$1000 = m/0.0094625 \times 10^{-3}$

$m = 9.46\ kg$

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10) Find the mass of carbon dioxide having a pressure of 20 psia at 200˚F with 10 ft³ volume.

A. 1.04 lbs B. 1.14 lbs C. 1.24 lbs D. 1.34 lbs

Solution:

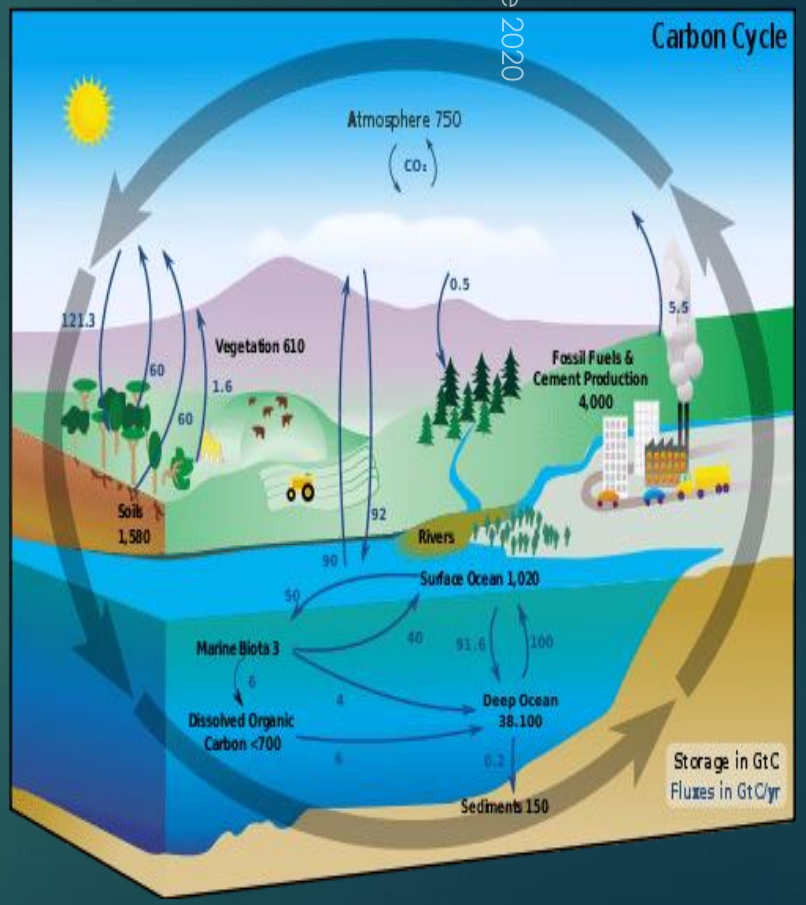
PV = m R T

(20 x 144)(10) = m

(1545/44)(200 + 460)

m = 1.24 lbs

Carbon dioxide is a chemical compound composed of one **carbon** and two oxygen atoms. It is often referred to by its formula CO2. It is present in the Earth's atmosphere at a low concentration and acts as a greenhouse gas. In its solid state, it is called dry ice. It is a major component of the **carbon** cycle



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11) Find the heat needed to raise the temperature of water from 30˚C to 100˚C with 60% quality. Consider an atmospheric pressure of 101.325 kpa. Use the approximate enthalpy formula of liquid.

A. 293.09 KJ/kg B. 1,772.90 KJ/kg C. 1,547.90 KJ/kg D. 1,647.29 KJ/kg

Solution:

At 100˚C

$h_t = c_p\, t = 4.187\,(100) = 418.7$ KJ/kg

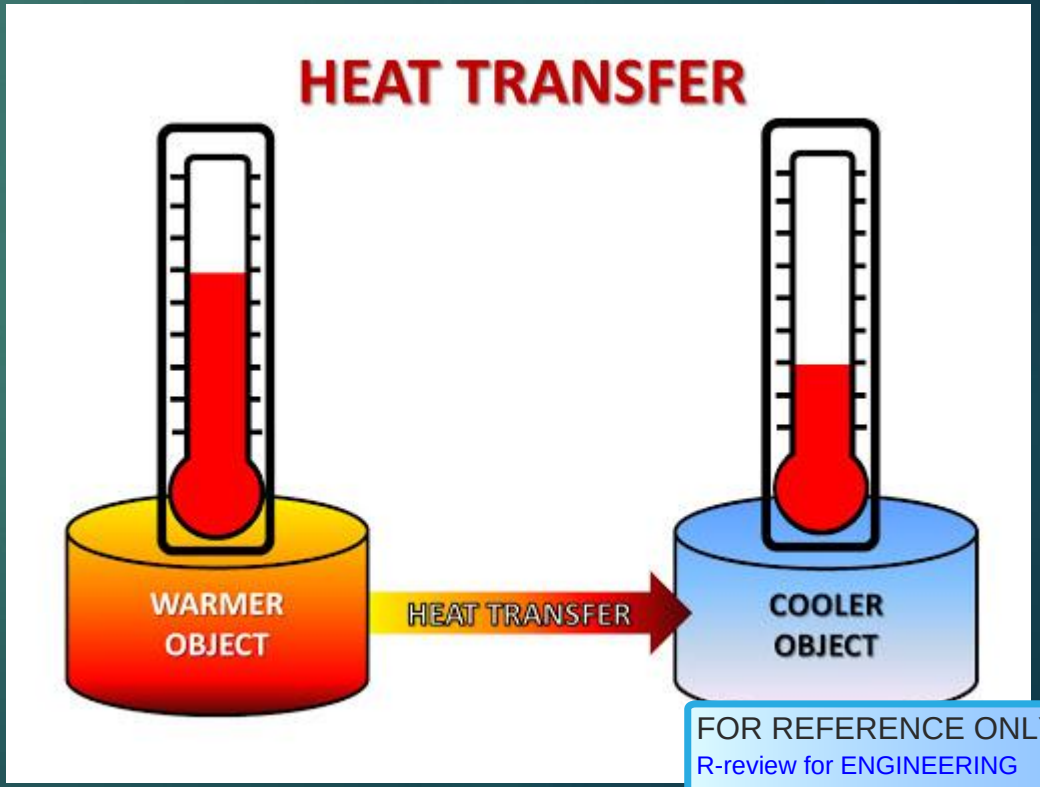
$h_{tg} = 2257$ KJ/kg

$h_2 = h_1 + x\, h_{tg} = 418.7 + 0.60(2257)$

$= 1{,}772.9$ KJ/kg

$Q = 1(4.187)(100 - 30) + 1(1772.9 - 418.7)$

$= 1{,}647.29$ KJ/kg



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12) Find the enthalpy of water at 212˚F and 14.7 psi if the dryness factor is 30%. Use the approximate enthalpy formula of liquid.

A. 461 Btu/lb *B. 471 Btu/lb C. 481 Btu/lb D. 491 Btu/lb

Solution:

$h_t = (^\circ F - 32) = (212 - 32) = 180$ Btu/lb

$h_{tg} = 970$ Btu/lb

$h = h_t + x\, h_{tg}$

$h = 180 + 0.3(970) = 471$ Btu/lb

The steam dryness fraction is used to quantify the amount of water within steam. If steam contains 10% water by mass, it's said to be 90% dry, or have a dryness fraction of 0.9.

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